EP 20316(14)

PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 :
C23C 14/00, 14/24, 14/34, 14/54

A1

(11) International Publication Number: WO 98/54375

(43) International Publication Date: 3 December 1998 (03.12.98)

(21) International Application Number: PCT/AU98/00390

(22) International Filing Date: 26 May 1998 (26.05.98)

(30) Priority Data:
PO 7120 30 May 1997 (30.05.97) AU

(71) Applicant *(for all designated States except US)*: LINTEK PTY. LTD. [AU/AU]; 20 Bayldon Road, Queanbeyan, NSW 2620 (AU).

(72) Inventor; and

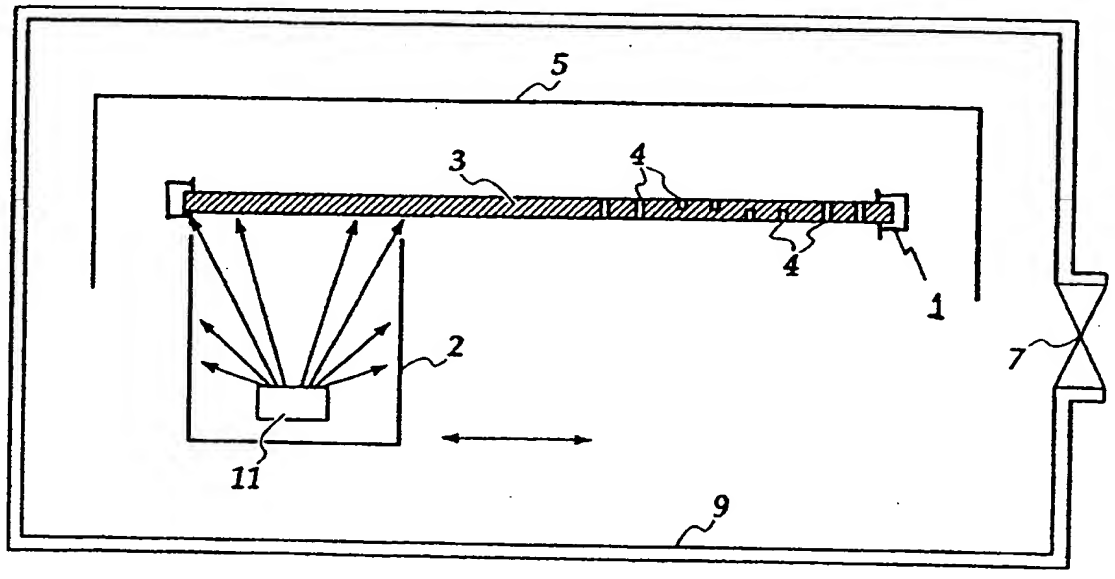
(75) Inventor/Applicant *(for US only)*: BUTLER, Steven [AU/AU]; 20 Bayldon Road, Queanbeyan, NSW 2620 (AU).

(74) Agent: PIZZEYS PATENT & TRADEMARK ATTORNEYS; P.O. Box 291, Woden, ACT 2606 (AU).

(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, GM, GW, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).

Published
With international search report.

(54) Title: VACUUM DEPOSITION SYSTEM INCLUDING MOBILE SOURCE



(57) Abstract

A vaccum deposition system in which the material source (11) is mobile and carries with it a directional shield (2) whereby an article (3) being coated is swept by a selected beam of material. The system is space efficient, reduces waste, facilitates recovery of waste and ensures efficient coating of bores.

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	ES	Spain	LS	Lesotho	SI	Slovenia
AM	Armenia	FI	Finland	LT	Lithuania	SK	Slovakia
AT	Austria	FR	France	LU	Luxembourg	SN	Senegal
AU	Australia	GA	Gabon	LV	Latvia	SZ	Swaziland
AZ	Azerbaijan	GB	United Kingdom	MC	Monaco	TD	Chad
BA	Bosnia and Herzegovina	GE	Georgia	MD	Republic of Moldova	TG	Togo
BB	Barbados	GH	Ghana	MG	Madagascar	TJ	Tajikistan
BE	Belgium	GN	Guinea	MK	The former Yugoslav Republic of Macedonia	TM	Turkmenistan
BF	Burkina Faso	GR	Greece			TR	Turkey
BG	Bulgaria	HU	Hungary	ML	Mali	TT	Trinidad and Tobago
BJ	Benin	IE	Ireland	MN	Mongolia	UA	Ukraine
BR	Brazil	IL	Israel	MR	Mauritania	UG	Uganda
BY	Belarus	IS	Iceland	MW	Malawi	US	United States of America
CA	Canada	IT	Italy	MX	Mexico	UZ	Uzbekistan
CF	Central African Republic	JP	Japan	NE	Niger	VN	Viet Nam
CG	Congo	KE	Kenya	NL	Netherlands	YU	Yugoslavia
CH	Switzerland	KG	Kyrgyzstan	NO	Norway	ZW	Zimbabwe
CI	Côte d'Ivoire	KP	Democratic People's Republic of Korea	NZ	New Zealand		
CM	Cameroon			PL	Poland		
CN	China	KR	Republic of Korea	PT	Portugal		
CU	Cuba	KZ	Kazakstan	RO	Romania		
CZ	Czech Republic	LC	Saint Lucia	RU	Russian Federation		
DE	Germany	LI	Liechtenstein	SD	Sudan		
DK	Denmark	LK	Sri Lanka	SE	Sweden		
EE	Estonia	LR	Liberia	SG	Singapore		

"VACUUM DEPOSITION SYSTEM INCLUDING MOBILE SOURCE"

Technical Field

This invention relates to a vacuum deposition system including a mobile source.

As used herein, the expression "vacuum deposition" is given a broad meaning and includes all processes in which an article is coated with a material under vacuum conditions and includes, for example, vapour deposition, sputtering and electron beam evaporation.

The invention has particular but not exclusive application to high vacuum vapour deposition systems for coating panels of circuit boards with electrically conductive material such as copper.

Background of Invention

Many methods exist for the vacuum deposition of electrically conductive materials, such as copper, onto circuit boards.

Once the material has been deposited on the board, it is necessary to etch away selected areas of the deposited material to thereby define electrically conductive paths on the surface of the circuit board. The etched material is usually recovered and recycled.

Known systems for coating panels of circuit boards involve one or more fixed sources which coat articles as the articles are moved about within the vacuum chamber.

Circuit boards often include blind or through holes which extend perpendicularly to the major surface of the circuit board. Difficulties exist in depositing conductive material into the bores of the blind holes and through holes, particularly where the hole has a relatively small diameter and/or large depth. This is due to the fact that the material must be travelling at a particular angle of incidence relative to the board in order to enter the hole and impinge on the bore. Thus, it will be readily understood that only a small percentage of the total material satisfies this

requirement and enters the hole.

This problem is sometimes overcome by simply increasing the duration of exposure to the material source. However, this approach has the disadvantage that the remainder of the board is overcoated, and the excess material must then be removed and recovered.

Summary of Invention

In one aspect the invention resides in a vacuum deposition system including:-

a vacuum chamber adapted to accomodate an article to be coated with a material;

vacuum generating means for generating a vacuum within the vacuum chamber;

a material source located within the vacuum chamber for coating the article;

transportation means for transporting the material source within the vacuum chamber, wherein the material source is omni-directional and includes a shield so that only a selected beam of material impinges on the article and wherein the article is swept by the beam of material.

In a highly preferred embodiment the shield is made out of said material to facilitate recovery of said material which impinges on the shield.

Preferably, the article is also moved within the vacuum chamber. In the preferred embodiment the article is moved within the vacuum chamber in a first direction and the material source is transported in a second direction which is generally orthogonal to the first direction.

In another aspect the invention resides in a vacuum deposition system including:-

a vacuum chamber adapted to accomodate an article to be coated with a material;

vacuum generating means for generating a vacuum within the vacuum chamber;

a mobile shielded material source located within the vacuum chamber.

Description of Drawings

In order that this invention may be more easily understood and put into practical effect, reference will now be made to the accompanying drawings which illustrate a preferred embodiment of the invention, wherein:-

FIG 1 is a schematic plan view of a vaccum deposition system with no panel present in the vacuum chamber; and

FIG 2 is an end sectional view of the vacuum deposition system with a panel present.

Description of Preferred Embodiment of Invention

The drawings illustrate a vacuum chamber 9 in which a material source 11 produces vapour for deposition on a panel 3 having holes 4 therein which are to be plated. Material source 11 is located in a shield 2 in a manner subsequently to be described. Material source 11 and shield 2 move in the direction illustrated by the arrow in FIG 1 and panel 3 moves transverse to this direction.

Panel 3 is gripped by panel handling grippers 1 and moves continuously or incrementally toward the rotating position 12 and source 11 moves back and forward across panel 3 at a speed and distance which is conducive to optimum coverage of the first side of the panel. When panel 3 reaches the rotating position 12 it is released by the panel handling grippers 1 and it is rotated 180 degrees by motion through vacuum shaft seal 13. The panel is then moved back to a load lock gate as the second side is coated in the same way as the first. At this point emission from the source may be reduced or stopped until the next panel enters through the load lock.

As can be seen in the drawings vacuum chamber 9 has an evacuation port 7, a plating material source 11 and a shield 2 surrounding source 11. Shield 2 is shaped to allow only a limited amount of atoms or ions from source 11 to reach substrate 3, and to capture all other plating materials for recovery or re-use.

The shield 2 may be made of the same material as the plating material and may be removed with the captured waste at the end of the plating run and be replaced with a new shield or may be made of a different material from which the waste material may be recovered by physical or chemical means. The shield 2 may be allowed to reach a temperature as imparted by the source or may be cooled by fluid cooling, heat sinking or other means well known to operators experienced in the art of heat exchange.

The shield 2 is preferably moved within the borders of the substrate so that virtually no plating material escapes into the chamber, although if it is required to have an even thickness of plating to the edge of the border the shield and source may be moved beyond the border. A cover shield 5 captures plating material which escapes in such circumstances.

Where the substrate has holes 4 to be plated by plating material, shield 2 is designed such that only those atoms or ions of the plating material from the source which will deposit on the hole bore to the desired depth in the smallest diameter holes are allowed to escape capture by the shield. This is particularly beneficial when these holes have a small diameter compared to the substrate thickness (high aspect ratio).

The design of shield 2 to facilitate this is effected by adjusting the height of the walls and the width of the opening of the shield until the optimum result in the holes is achieved. Generally when the source and shield are moved closer to the substrate the deposition rate will be faster and waste will be reduced.

Where holes are placed near the border of the substrate, the source is moved past the border to ensure that atoms or ions of the plating material sufficiently coat the bore of the holes facing the border. Cover shield 5 may be used to capture plating material which escapes the substrate border.

Where it is required to coat both sides of a substrate with plating material, rotating means invert

the panel or alternatively a source or sources are located on opposite sides of the substrate to simultaneously coat the substrate. In this case the substrate can be arranged vertically.

The preferred embodiment of the present invention has a number of advantages over the apparatus and methods of known vapour deposition systems.

It avoids the disadvantage of known systems in which a significant proportion of the plating material atoms or ions are deposited not only on the substrate but on the surrounding chamber and internal apparatus. This causes malfunctions and requires difficult cleaning operations. This is particularly wasteful if the deposition material is precious metal.

The bore of holes in the substrate is more reliably and fully plated (whether blind or through holes), particularly when these holes have a high aspect ratio in relation to the substrate thickness, than is the case with known prior art systems in which difficulty is experienced in that by the time sufficient plating material is deposited in the centre bore of the holes, more plating material than desired ends up on the substrate surface.

It reduces the prolonged deposition times of prior art systems which can cause excess substrate heating which may cause damage.

It also reduces both the waste of plating materials and the radiation of excess heat to the chamber and internal apparatus occurring in prior art systems in which additional material plating sources are placed outside of the border of the substrate.

It allows efficient coating of a substrate surface whilst reducing substrate heating and captures the majority of the waste for plating material recovery and or re-use. The system also effectively plates the bore of holes, especially high aspect ratio holes in a substrate, whilst reducing the thickness of the surface deposit and reducing substrate heating. This is

particularly advantageous when the substrate is to become a printed circuit where some of the surface plating will subsequently be removed by etching means.

It will of course be realised that whilst the above has been given by way of an illustrative example of this invention, all such and other modifications and variations hereto, as would be apparent to persons skilled in the art, are deemed to fall within the broad scope and ambit of this invention as is herein set forth.

The Claims defining the Invention are as follows:-

1. A vacuum deposition system including:-

a vacuum chamber adapted to accomodate an article to be coated with a material;

vacuum generating means for generating a vacuum within the vacuum chamber;

a material source located within the vacuum chamber for coating the article;

transportation means for transporting the material source within the vacuum chamber, wherein the material source is omni-directional and includes a shield so that only a selected beam of material impinges on the article and wherein the article is swept by the beam of material.

2. A vacuum deposition system as claimed in claim 1, wherein the shield is made out of said material to facilitate recovery of said material which impinges on the shield.

3. A vacuum deposition system as claimed in claim 1, wherein the article is also moved within the vacuum chamber.

4. A vacuum deposition system as claimed in claim 3, wherein the article is moved within the vacuum chamber in a first direction and the material source is transported in a second direction which is generally orthogonal to the first direction.

5. A vacuum deposition system including:-

a vacuum chamber adapted to accomodate an article to be coated with a material;

vacuum generating means for generating a vacuum within the vacuum chamber;

a mobile shielded material source located within the vacuum chamber.

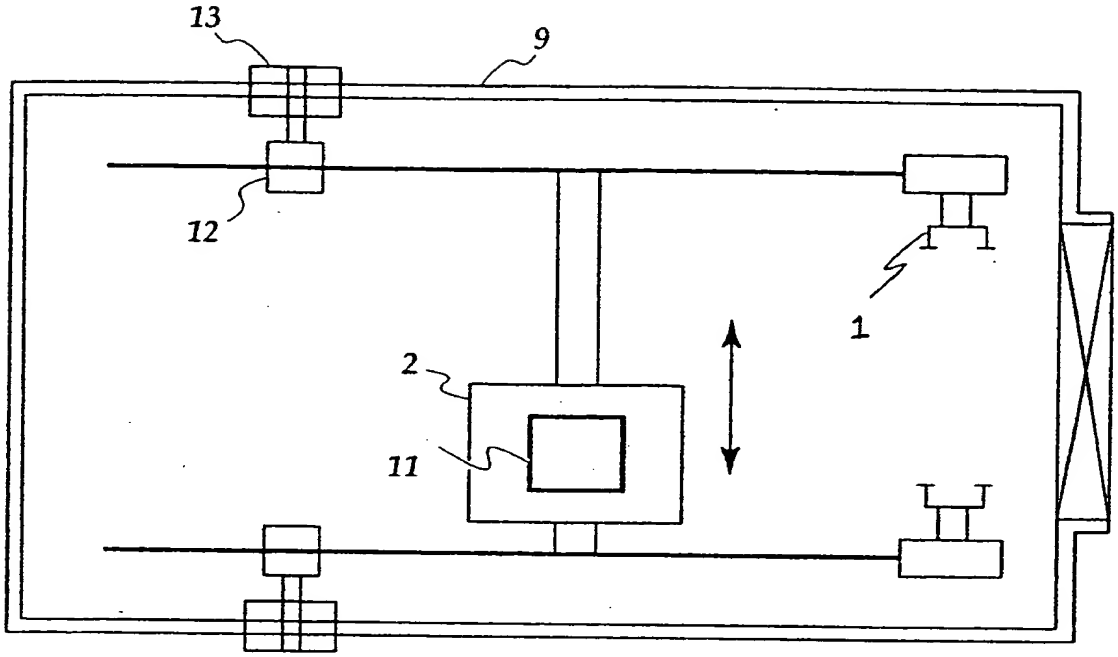


Fig. 1.

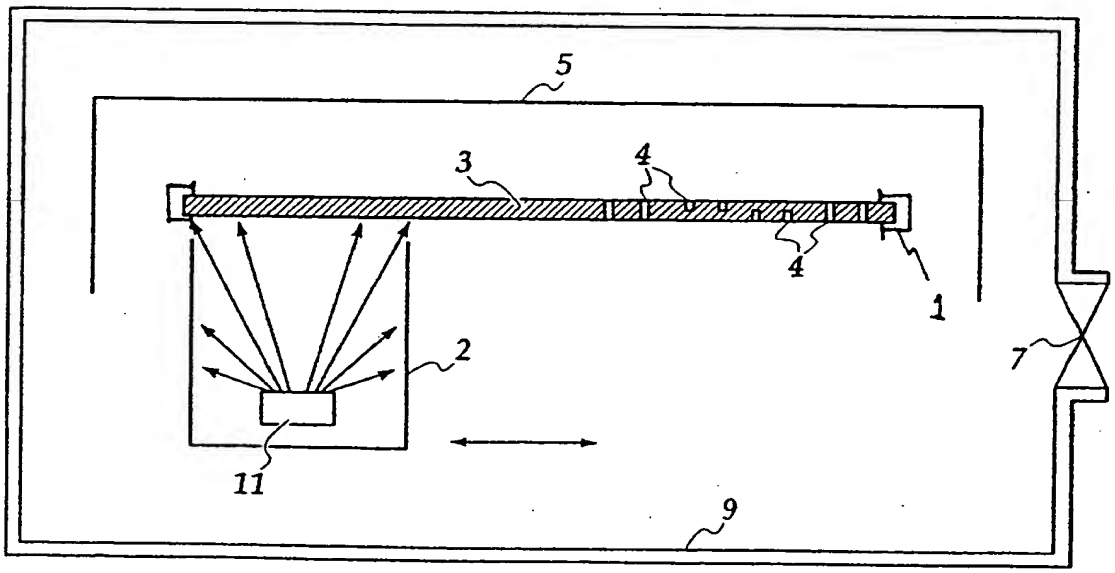


Fig. 2.

INTERNATIONAL SEARCH REPORT

International Application No.
PCT/AU 98/00390

A. CLASSIFICATION OF SUBJECT MATTER

Int Cl[6]: C23C 14/00, 14/24, 14/34, 14/54

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC: C23C 14/-, C23C 15/00, C23C 13/08

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
AU: C23C 14/00, C23C 16/-, C23C 14/24, 14/34

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
DERWENT: Shield: or Protect: or Surround: or enclos: and mobil: or move: or transport:
JAPIO: same as above

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5334302 (KUBO et al) 2 August 1994 see abstract, figure 7 and claims	1-5
A	EP 477474 A(MITSUBISHI JOKOGYO KABUSHIKI KAISHA) 1 April 1992	1-5
A	US 5069770 A (GLOCKER) 3 December 1991	1-5
A	US 5182567 A (WILDER) 26 January 1993	1-5
A	WO 95/11517 A (PIXEL INTERNATIONAL) 27 April 1995	1-5

[X] Further documents are listed in the continuation of Box C

[X] See patent family annex

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search
30 June 1998

Date of mailing of the international search report
- 7 JUL 1998

Name and mailing address of the ISA/AU
AUSTRALIAN PATENT OFFICE
PO BOX 200
WODEN ACT 2606
AUSTRALIA
Facsimile No.: (02) 6285 3929

Authorized officer
M. BREMERS
Telephone No.: (02) 6283 2052

orm PCT/ISA/210 (second sheet) (July 1992) copbko

D: <WO___9854375A1_I_>

INTERNATIONAL SEARCH REPORT

International Application No.
PCT/AU 98/00390

C (Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5536381 A (LEE) 16 July 1996	1k-5
A	WO 96/35822 (CENTRE DE RECHERCHES METALLURGIQUFS) 14 November 1996	1-5

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No.
PCT/AU 98/00390

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member					
US	5334302	JP	6200375	JP	5234893		
EP	477474	AU	83486/91	CA	2044976	JP	4136169
		US	5169451				
US	5069770	NONE					
US	5182567	CA	2052719	DE	4133615		
WO	95/11517	EP	674804	FR	2711450	US	5605608
US	5526381	NONE					
WO	96/35822	US	5612682				

END OF ANNEX